

REMARKS/ARGUMENTS

Favorable consideration of this application as presently amended and in light of the following discussion is respectfully requested.

Claims 1-6, 11, and 13-16 are pending in the application, with Claims 13-16 added and Claims 1, 5, 6, and 11 amended by the present amendment.

In the outstanding Office Action, the title was objected to; Claims 1, 3, 6, and 11 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Suzuki (U.S. Patent No. 6,002,123) in view of Egawa et al. (U.S. Patent No. 5,572,265); Claim 2 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Suzuki in view of Egawa et al. in further view of Watanabe et al. (U.S. Patent No. 5,512,950).

Claims 1, 5, 6, and 11 are amended to more clearly describe and distinctly claim Applicants invention. Support for these amendments is found in Applicants' originally filed specification.¹ New dependent Claims 13-16 recite features disclosed in Applicants' original specification² where the p-type region recited in claims 13-16 corresponds to the region (hatched thin layer) formed on the n-type region "n" of the photodiode 31 of Applicants' FIG. 3.

Briefly recapitulating, amended Claim 1 is directed to an image pickup apparatus comprising an array of unit cells arranged in rows and columns, each unit cell having

- a light-receiving device configured to receive light and generate an electric charge corresponding to the light,
- a charge-accumulating section configured to accumulate the electric charge generated by the light-receiving device,
- a transfer device configured to transfer the electric charge from the light-receiving device to the charge-accumulating section,

¹ Specification, page 14, line 12; FIG. 2.

² Specification, page 14, lines 21-23; Fig 3.

- a charge-limiting device configured to limit the electric charge accumulated in the charge-accumulating section, and
- an amplifying device configured to amplify a voltage signal corresponding to the electric charge in the charge-accumulating section;

The image pickup apparatus also comprises a plurality of vertical signal lines extending along the columns of unit cells, respectively, each configured to receive the amplified voltage signal amplified by the amplifying device of any unit cell of the associated column. The image pickup apparatus also comprises a control circuit configured

- to control each of the unit cells,
- to cause the charge-limiting device to limit the electric charge generated by the light-receiving device during a first period and transferred to the charge-accumulating section through the transfer device,
- to cause the charge-accumulating section to hold the electric charge limited by the charge-limiting device, and
- to add to the electric charge held in the charge-accumulating section, an electric charge generated by the light-receiving device during a second period following the first period and transferred to the charge-accumulating section through the transfer device.

Independent Claims 5, 6, and 11 are directed to alternative embodiments of Applicants' invention, Applicants' claimed image pickup devices allow for increased dynamic range and simultaneous signal read out.³

In the passages cited in the Official Action, Suzuki discloses a solid-state imaging device including a pixel section 52 having three transistors 56, 58, and 60 formed as a floating diffusion portion into which accumulated charge of the photodiode (charge

³ Specification, page 4, lines 25-27.

accumulating portion) 54 is transferred through a channel below a transfer gate 64.⁴ Transfer gate 64 is connected to a transfer control line 70. Suzuki also discloses a reset gate 68 connected to a reset line 116. As noted in the Official Action, Suzuki does not disclose or suggest Applicants' control circuit.

Before discussing the control circuit of Egawa, Applicants direct the Examiner's attention to the first embodiment of Suzuki shown in FIGs. 2-4. As shown in FIGs. 2-3, a voltage V_h is applied to a gate 40 via reset line 16 so as to reset the photodiode (source 36). Subsequently, during the term T_1 , voltage V_m is applied to the gate 40. Thus, as shown in FIG. 4, the amount of charge accumulated in the photodiode 36 is limited to Q_{max1} (overflow level). That is, a charge-limiting operation is performed by gate 40. Subsequently, voltage V_1 is applied to gate 40, and the overflow level is increased from Q_{max1} to Q_{max2} . Thus, as shown in FIG. 4, the amount of charge accumulated in the photodiode 36 is $Q_{max1} + Q_1$ or $Q_{max2} + Q_2$. Furthermore, at time c , voltage V_n is applied to the transistor 34 via vertical selection line 18 and a signal corresponding to the charge accumulated in the photodiode 36 is output. Applicants draw the Examiner's attention to the fact that charge is accumulated in the photodiode 36 and a charge limiting operation is performed by gate 40. In Suzuki, such operations expand the dynamic range of the image pickup device.

With this as background, Applicants now draw the Examiner's attention to FIG. 6 as cited in the outstanding Official Action. While Suzuki does provide any details on the operation of the circuit of FIG. 6, Suzuki discloses that the circuit operates substantially similar to the circuit of FIGs. 2-4. That is, in the circuit of FIG. 6 of Suzuki, similar to the circuit of FIG. 4, a charge accumulation operation is performed in the photodiode 54 by controlling the voltage applied to the transfer gate 64 in a manner similar to the use of gate 40 to control photodiode 36 in FIG. 3. Because the charge-adding operation of Suzuki is

⁴ Suzuki, column 6, lines 35-43; Fig. 6.

performed in the photodiode 54 (light-receiving device), the charge-adding operation is not performed in the floating diffusion portion 62 as stated in the Official Action. Similarly, the charge-limiting of Suzuki operation is not performed by control line 116 (to reset gate 68) as stated in the Official Action but by control line 70 (to transfer gate 64).

However, Applicants' independent claims are directed to embodiments where a charge-adding operation is performed not by the light-receiving device but by the charge-accumulating section separate from light-receiving device. Furthermore, Applicants' independent claims are directed to embodiments where a charge-limiting operation is performed not by the transfer device but by the charge-limiting device. For example, Claim 1 recites, *inter alia*, a plurality of cells each having

- a light-receiving device configured to receive light and generate an electric charge corresponding to the light,
- a charge-accumulating section configured to accumulate the electric charge generated by the light-receiving device,
- a transfer device configured to transfer the electric charge from the light-receiving device to the charge-accumulating section,
- a charge-limiting device configured to limit the electric charge accumulated in the charge-accumulating section, and

Claim 1 also recites, *inter alia*, a control circuit configured

- to cause the charge-limiting device to limit the electric charge generated by the light-receiving device during a first period and transferred to the charge-accumulating section through the transfer device,
- to cause the charge-accumulating section to hold the electric charge limited by the charge-limiting device, and

- to add to the electric charge held in the charge-accumulating section, an electric charge generated by the light-receiving device during a second period following the first period and transferred to the charge-accumulating section through the transfer device.

Therefore Applicants submit that Suzuki not only fails to disclose or suggest a control circuit, as acknowledged in the Official Action, but Suzuki also fails to disclose or suggest Applicants' claimed charge accumulating section as well as Applicants' claimed transfer device.

Applicants have considered the Egawa reference and submit Egawa does not cure the deficiencies of Suzuki. Egawa discloses a solid state imaging apparatus where, as shown in FIGS. 7C and 7D, a charge-adding operation ($Q_a + Q_b$) is performed in the photodiode PD, and not in a separate charge accumulating section as recited in Applicants' independent claims. Furthermore, in Egawa, as is obvious from FIG. 7C, a charge-limiting operation is performed by the transfer gate of I-CCD and not in a separate transfer device as recited in Applicants' independent claims.

Regarding Applicants' Claim 11, as already stated, in Suzuki charge is accumulated not by the floating diffusion portion 62 but by the photodiode 54. Thus, after charge is transferred from the photodiode 54 to the floating diffusion portion 62, a signal corresponding to the transferred charge is immediately amplified by the transistor 58.⁵ Furthermore, in Suzuki, charge is not transferred from the photodiode 54 to the floating diffusion portion 62 during the vertical blanking period. Therefore, Suzuki does not disclose or suggest a charge transferred from the light-receiving device is held by the charge-accumulating section from the time in the vertical blanking period to the time of amplifying operation. That is, Suzuki does not disclose or suggest Applicants' claimed charge-

⁵ Suzuki, column 7, lines 7-15

accumulating section or Applicants' claimed control circuit. Furthermore Egawa is directed to a CCD-type image pickup device and not to an amplification-type image pickup device.

Because Egawa does not disclose an amplifying operation, Egawa does not disclose or suggest a control circuit configured to control amplification as recited in Applicants' Claim 11.

As none of the cited prior art, individually or in combination, disclose or suggest all the elements of independent Claims 1, 5, 6, and 11, Applicants submit the inventions defined by Claims 1, 5, 6, and 11, and all claims depending therefrom, are not rendered obvious by the asserted prior art for at least the reasons stated above.⁶

Accordingly, in view of the present amendment and in light of the previous discussion, Applicants respectfully submit that the present application is in condition for allowance and respectfully request an early and favorable action to that effect.

Respectfully submitted,

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⁶ MPEP § 2142 "...the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, and not based on applicant's disclosure. In re Vaack, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991)."